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IDENTIFYING THE DIFFERENCES BETWEEN STATIONARY OFFICE SUPPORT AND MOBILE WORK SUPPORT: A CONCEPTUAL FRAMEWORK

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ABSTRACT

The rapid development of mobile technologies provides a great potential to support mobile work that was not supported by traditional stationary information systems. To realize this great potential, it is important for us to fully understand the nature of mobile work in order to develop efficient and effective support for mobile workers. In this paper we propose a conceptual framework and use this framework to analyze four fundamental aspects of mobile work: mobile workers, mobile tasks, mobile context, and mobile technology. The key differences between office work support and mobile work are highlighted. The conceptual framework can be used to identify research issues and provide guidelines for the development of effective mobile work support systems.

KEYWORDS

Mobile work support, stationary office support, mobile workers, mobile tasks, mobile context, mobile technology

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1. INTRODUCTION

The wide spread of PCs in office environment in 1980's brought the idea of office automation that focuses on improving the productivity of office workers. Desktop office applications such as word processors and spreadsheets became very popular. In 1990's, the rapid growth of Internet and web technology made it possible to link computers all over the world. Remote data access and cooperation, without need of traveling, became possible. However, the desktop PCs and fixed-line Internet connections can only be used to support stationary office workers. The rapid development of mobile communication and portable mobile devices in recent years created a great potential for us to move from traditional office support to mobile workforce support. With the use of a variety of handheld devices such as cell phones, PDAs (Personal Digital Assistant) and pocket PCs, mobile workers now can communicate and collaborate with each other anywhere, anytime, in a dynamic mobile environment without the restrictions, in a traditional stationary office environment.

These years, corporations are now becoming more active in deploying new mobile business solutions to achieve tangible business benefits (Alanen and Audio, 2003). In the U.S., wireless enterprise data subscribers are expected to reach 26 million by 2005. Indeed, some 30% of Fortune 1000 IT managers currently have wireless networks to access company specific applications and another 53% are either in trial or are investigating options (Booz-Allen and Hamilton, 2001). The implementation of mobile work support brings business competitive edges as well as improves work productivity. For examples, UPS introduced a nationwide cellular-based wireless data service in February 1993. The implementation of mobile solution resulted in the increase in market

share and the retention of the company's competitive edge. They also benefit from the application in higher productivity of operational staff resulting from the revamping of business processes reductions in parcel-handling times, improved accuracy, elimination of illegible handwritten records, speedier package delivery (Mobileinfo, 2004). Xerox equipped all their service representatives in late 90s with wireless-enabled hand-held devices. They can access parts information from their host systems and get their repair schedules without returning to the office (Mobileinfo, 2004). Mobile technology companies provide many mobile business solutions. For example, Mobile Computing Company provides solutions for mobile workers since 1984. Their solutions have been successfully used by USA Today for newspaper delivery and Esso/Exxon for gas fill up service (Mobilecom, 2005).

Despite its early application and the great potential of mobile business, we still lack the theory to fully understand the nature and the requirement of mobile work support. Without this understanding, it will be difficult to develop efficient and effective support for mobile workers. As shown by Luff and Heath (1998), misunderstanding the nature of mobile work may be problematic and lead to the technologies being used in unexpected ways. For example, mobile devices was introduced to provide communication and collaboration support between foreman and field workers at a construction site. However, instead of being used as a collaboration tool, it was primarily used by workers as a data collection device. That is not to say that it failed as a useful tool, but merely that it was not useful for its intended purpose (Luff and Heath, 1998).

The existing information systems research has been mainly focused on stationary office environment. Recent developments in wireless telecommunications and mobile computing will require us to rethink many fundamental assumptions underlying the IS research (Lyytinen and Yoo, 2002). In order to make a clear and comprehensive understanding of mobile workforce support, we need to answer the following fundamental questions: who are the mobile workers? What is the nature of the tasks performed by mobile workers? What are the characteristics of the mobile environment or context? What are the tools available for mobile workers? Since we are familiar with traditional office environment, it will be better to compare the differences between stationary office work support and mobile work support when answering the questions mentioned above.

To answer these questions, we propose a conceptual framework of mobile work support that consists of four aspects: mobile workers, mobile tasks, mobile context, and mobile technology support. The paper is structured as follows: A conceptual framework is proposed in section 2. Then the four aspects of the model are discussed in the section 3 to section 6 respectively. We suggest some important research questions in section 7 and come to the conclusion in section 8.

2.   CONCEPTUAL FRAMEWORK

Tarasewich (2000) proposed a context model for interface design of mobile applications. The model analyses the context in three categories: the environment, the participants, and the activities. The "environment" category includes location, orientation,

physical properties and the availability and quality of mobile devices and communications. "Participants" includes the location, orientation, and personal properties of the user(s) and other participants in the environment. "Activities" are the tasks and goals of participants and events in the environment. Kristoffersen and Ljungberg (2000) proposed a reference model of mobile IT-use. The three main components of the model are environment, modality of mobility and applications. Environment is the physical and social surroundings. Modality is the fundamental patterns of motion. Applications are the combination of technology, program and data used. Ramampiaro et al. (2003) propose that the mobile task characteristics are divided into four main categories: 1) General – used to describe task structures and attributes that are indirectly related to mobility. 2) Information – used to specify the information requirements that must be fulfilled to support a task. 3) Location – used to specify if a task or back-end system support depends on geographical locations, and 4) Time – used to investigate the temporal properties of a task, and the system support for these properties. Kahihara and Sorensen (2002) expand the concept of geographical mobility to embrace spatial, temporal and contextual mobility. Zhang et al. (2002) and Yuan and Zhang (2003) addressed the key differences between m-commerce and e-commerce in terms of technology, application, and business models. As we can see, all the above studies have captured some important aspects of mobile commerce. But they are not specifically focused on mobile work support.

In order to understand the nature of mobile work and mobile work support, we propose a conceptual framework of mobile work. Here mobile work refers that mobile workers conduct mobile tasks in a mobile context by means of mobile technology support.

Our conceptual framework therefore consists of four aspects: mobile workers, mobile tasks, mobile context, and mobile technology that address the questions of Who, What, Where, When and How respectively. The model is illustrated in Figure 1. We highlight the dimensions of the framework in table 1 and use the model to compare the differences between stationary office work and mobile work in Table 2.

Figure 1 Inserted here

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Table 2 Inserted here

3.   MOBILE WORKERS

In general, the mobile worker can be defined as the worker who is away from the office or desk more than 20 percent of the time, who has a job with no desks or office, or who must perform work that requires mobile communications (Gartner, 2002). To describe the mobile worker, other terms also have been coined such as "road warriors" and "nomads". These terms distinguish workers who are moving, from workers who are distributed and co-located (Dahlbom and Ljungberg, 1998).

Mobile workers can be further classified based on the concept of mobility. There are two kinds of mobility. One is local mobility, also called wandering, which refers to

people spending a considerable amount of time walking around locally. The other is remote mobility, which includes traveling and visiting. Traveling is the process of going from one place to another in a vehicle. Visiting is spending time in one place for a prolonged period of time before moving to another place (Whittaker et al., 1994; Bellotti and Bly, 1996; Kristoffersen and Ljungberg, 2000).

Usually, office workers are mostly knowledge workers while mobile workers include not only knowledge workers (so called white collar workers) such as mangers, real estate agents but also field workers (so called blue collar workers) such as taxi drivers, service workers as well (Brodie and Perry, 2001).

The leading job categories of mobile workforce include general executives, sales, transportation, construction, field service, healthcare, finance and education. They make up 78 percent of the total mobile workforce (Gartner, 2002).

Knowing who are the mobile workers helps to identify the target market of mobile work support. It is also important to study the characteristics of various mobile workers in order to tailor mobile work support to meet their specific needs and concerns.

4.   MOBILE TASK

Task is the activities performed by workers to accomplish an objective. In order to understand the nature of mobile work and the differences between mobile work and stationary work, we need to identify the dimensions or characteristics of mobile tasks. Most the previous studies on tasks were oriented to stationary task (Perrow, 1967; Poole, 1978). For mobile task, location/time dependency is a very important characteristic

(Wiberg and Ljungberg, 1999; Balasubramanian et al., 2002). It is the key characteristic that distinguishes mobile work from stationary work. Another feature of mobile work is associated with multi-task handling, such as talking through the cell phone while driving. Thus, we analyze the mobile work along two dimensions: location/time dependency, and multi-task handling.

4.1   Location/Time Dependency

Mobile work requires mobile workers present on the site physically and usually needs to be finished within a specific time period, such as emerging rescue or service delivery. Wiberg and Ljungberg (1999)'s ethnographic study of mobile telecommunication engineers in Sweden examined how the work they did was dependent on place and time. Mobile workers often have places of non-negotiable importance, that is, travel could not easily be avoided: you cannot reframe the earth by putting away distance. Because of place dependence, there are time frames that seem very difficult for mobile workers not to do certain tasks within certain time. Mobile work has time frames that are not negotiable, so the work is dependent upon them. In contrast, with the use of Internet connection, office workers can do jobs remotely such as placing an international purchasing order anywhere anytime without the need for traveling and thus the job is location and time independent (Wiberg and Ljungberg, 1999).

4.2   Multi-task Handling

Mobile workers often perform actions other than information processing. Thus, while mobile workers are conducting their main actions, they may experience the attention focusing or distraction problems. This issue are confirmed by many studies. Kristoffersen and Ljungberg's (1999) studied mobile work in the two settings of telecommunication service engineers and maritime consulting staff. They explored four features of the mobile work. Tasks external to operating the mobile computer are the most important, as opposed to tasks taking place "in the computer" (e.g. a spreadsheet for an office worker). Users' hands are often used to manipulate physical objects, as opposed to users in the traditional office setting, whose hands are safely and ergonomically placed on the keyboard. Users may be involved in tasks ("outside the computer") that demand a high level of visual attention (to avoid danger as well as monitor progress), as opposed to the traditional office setting where a large degree of visual attention is usually directed at the computer monitor. Users may be highly mobile during the task, as opposed to in the office, where doing and typing are often separated. Pascoe et al. (2000)'s study on the scientists observing giraffe behaviour in Kenya found that in the situation of "using while moving", the user needs to spend as much time as possible in observing and to minimize the time devoted to interacting with the recording machine.

5.   CONTEXT

There is no universally accepted definition of context. In the American Traditional Dictionary, context is defined as "the circumstances in which an event

occurs". In our paper, the context of mobile work can be defined as the circumstances in which mobile tasks are being carried out by mobile workers. Time and place are the very important ways for understanding the context (Wiberg and Ljungberg, 1999). Balasubramanian et al. (2002) suggested jointly mapping a specific activity in terms of the degree to which the activity is constrained (or flexible) spatially and the degree to which the activity is constrained (or flexible) temporally. Here we use working place and work temporal structure to characterize the context of mobile work.

5.1   Work Place

According to Harrison and Dourish (1996), a place is a particular geographic location invested with understandings of behavioral appropriateness, cultural expectations, and so forth. It is a space with something added - social meaning, convention, cultural understandings about the role, function and nature and so on. In general, stationary office workers work in a single and stable workplace, while mobile workers work in different and diversified places. We discuss the mobile work place from the following aspects: physical surroundings, facilities, uncertainty, and interference.

In terms of physical surroundings, stationary workers own their workplace. The workplace is designed to fit into the needs of stationary workers. Stationary workers can structure and interpret place for their individual or interactive purposes. The objects they work with most are generally arranged close to them for easy access while other materials are kept further away. In contrast, mobile workers have to carry a "portable office" such as a briefcase and mobile devices or/and borrow public or other people's places as their

work place such as hotel or customer's location. Mobile workers need to adapt to the different and diversified workplaces. These different places facilitate or restrict the workers with different possibilities for configuring and reconfiguring their relationships with others, different possibilities for performing actions, different possibilities for habitual action through which meaning and identity could be attached to place, and different possibilities for temporal structure configuration (Brown and O'Hara, 2003). The constraints of the places have a great impact on the kind of work activities that can be carried out there. If possible, mobile workers arrange their activities so that the activities they do fit the places they are in. In this respect, place may be an important determinant in the ordering of work activities for mobile workers. They convert, adjust and configure the spaces that are available to them so as to be able to do their work in them (Brown and O'Hara, 2003).

In term of facilities, a stationary office generally is fully equipped and provides adequate support for the work. In contrast, mobile work facilities are often limited due to inadequate capability of mobile devices and communication channels or environmental constraints. Important documents may not be easily accessed through a cell phone. Furthermore, if a task must be carried on, resource limitations often constrain the methods available to perform the task (Gray and Salber, 1997). We discuss the details of technology support for mobile work later in the section 6.

One of the most important characteristics of mobile work is that there is less predictability (Perry et al., 2001). That is, there are more uncertainties or exceptions. While performing the planed tasks, mobile workers may encounter unplanned situational

acts led by unplanned context changes (Tamminen et al., 2004). During traveling, the traffic conditions and public transportation timetable changes may lead to uncertainty. The people you want to meet may not appear and you even do not know where he/she is. A field service worker may discover that he forgot to bring a tool or material to fix an unexpected problem. In general, the mobile work is accompanied with great uncertainty.

Mobile workers generally experience more interference than stationary workers. It is relatively easy for a stationary worker to control or reduce a possible interference. But a mobile worker usually cannot avoid external interference but have to cope with it. When traveling using public transportation services, there is little privacy and verbal discussing on confidential matters can be overheard (Brown and O'Hara, 2003). Besides disturbed by others, mobile workers may also disturb others. An unexpected cell phone ring at a formal meeting or social event may make the phone owner embarrassed and loud talk over cell phone in public may also disturb others. The wide use of cell phones in public settings has created a new type of pollution, called cell phone pollution.

5.2 Temporal Structure

Time is an essential feature of social and organizational life (Adam et al., 2002). Traditionally, there are two views on time: objective view and subjective view, or clock time and event time (Jacques, 1982; Kern, 1983; Adam, 1994; Blyton, 1989). Objective view of time aligned with a Newtonian assumption of time as abstract, absolute, unitary, invariant, linear, mechanical, and quantitative. In a subjective view, time is seen as relative, contextual, organic, and socially constructed (Adam, 1990; Glucksmann, 1998).

Orlikowski and Yates (2002) proposed a third view, the practice-based perspective on time, which suggests that people in organizations experience time through the shared temporal structures. Like social structures in general, different temporal structures constrain and enable different actions. Time and space are always interlinked – changes in space provoke changes in time, and vice versa (Giddens, 1990). Time geography perceives time and space as inseparable and makes considerable effort to understand social phenomena in terms of a "time–space ecology" represented by dynamic "time–space maps" (Hagerstrand, 1975).

Building on the theory of time we discussed above, we contend that activities affect and shape the temporal structures and the temporal structures constrain and enable different actions. The temporal structure not only includes the temporality, but also includes work place, since both of them are closely related with the activities (events). The basic unit of temporal structure is time frame. Different places construct different time frames. The temporal structure for stationary work and mobile work is illustrated in figure 2.

Figure 2 Inserted here

There are three features for the temporal structure of mobile work. Firstly, the temporal structure of mobile work is irregular, while the temporal structure of stationary work is regular. Secondly, the time frame for mobile work is narrower than that for stationary work. On one hand, a narrower time frame constraints activities that mobile

workers may perform (Brown and O'Hara, 2003). On the other hand, since activities must be completed in a certain time frame, the narrower time frame means more urgent and time critical in information access and exchange compared with wider time frame in the situation of stationary work. That is, why anytime access means much more for mobile work than for stationary work. Thirdly, for stationary work, time management generally can be more controllable, since the resources for performing the work are generally easier to access compared with mobile work. Stationary workers can arrange their work with less restriction. For mobile work, time management tends to be less under control. In some time frames, a mobile worker does not have the available resources to perform the work he/she wants to do. Thus there exists so called "dead time", that is, time occurs between tasks, in which the workers usually have little control over the resources available to them (Perry et al., 2001).

Our analyses are consistent with Tamminen et al. (2004)'s study. They contend that time plays a crucial role for the mobile activities. Fluctuations in the importance of time and space as contextual factors are called temporal tensions. Temporal tensions refer to situations where time becomes problematic in relation to the action at hand and where, at the same time, the temporal aspect of a situation is actively used to orient action (making temporal tensions in actions visible).

6. MOBILE TECHNOLOGY

Technology is viewed as human-made advancements that increase the effectiveness and efficiency of specific tasks (Good and Schultz, 2000). Mobile technologies can be

seen as new resources for accomplishing various everyday activities that are carried out on the move (Tamminen and Oulasvirta, 2004). Varshney and Vetter (2002) proposed a mobile commerce application framework. This framework has four levels: m-commerce applications, user infrastructure, middleware, and network infrastructure (Varshney and Vetter, 2002). We discuss mobile technology in terms of mobile devices, wireless network infrastructure, and mobile work support applications.

6.1   Mobile Devices

Since mobile workers are frequently in the move, the most unique and distinguishing characteristic of mobile technology is the ability to physically carry mobile devices with the user, that is, the portability. To be portable requires minimizing the size and weight thus limits capabilities in input, processing, display, memory, and power supply in comparison with relatively powerful PCs used in office environment (Yuan and Zhang, 2003).

In a traditional office setting, the usability issue is focused on human-computer interaction in a stable environment. But the usability of mobile devices is heavily dependent on and constrained by mobile context which is diverse and more unstable (Tarasewich, 2003). For instance, when driving, it is dangerous to make a cell phone call by pushing the phone number keypad. Voice activated phone call can be more convenient and safe. To develop meaningful mobile work support application, we should seriously take care of capacity limitation and operation feasibility of mobile devices in different scenarios.

6.2   Wireless Network Infrastructure

The fixed-line network connection to stationary office is less expensive, fast, and more reliable than wireless network connection to the mobile devices carried by mobile workers. Today, we still do not have universal coverage for wireless network connections. Global roaming and interconnection between different wireless networks is still difficult. However, as mobile technology continues to advance, we may eventually to be connected anywhere and anytime.

Location identification refers to the ability to locate the geographical position of a user through a mobile device. There are two types of location identification technologies: Satellite-based such as GPS (Global Positioning System) and network-based such as the cell pone location identification system (Yuan and Zhang, 2003). Since many mobile workers' job rely on the location related information, location identification capability is vital for mobile work support such as taxi dispatch, traveling navigation, supply chain logistics etc.

The Internet is a global network of networks based on a well-established protocol, TCP/IP (Transmission Control Protocol/ Internet Protocol). In contrast, wireless network use a variety of wireless technologies and standards (Yuan and Zhang, 2003). The lack of universal standards of wireless network brings about the compatibility problems (Gandal 2003). It is still difficult to use a single cell phone when traveling in any countries for universal access.

While the reliability of fixed-line network is usually high, the reliability of mobile network is relatively low. Radio signal may be weak or interfered, connection may be

interrupted, and data may get lost. Although there are many advantages, the mobile communication infrastructure is still not mature yet.

6.3   Mobile Work Support Applications

The traditional information systems are oriented to support stationary office workers. For example, Microsoft office is typical software for Office Automation and groupware software such as Lotus Notes are used for group collaboration. There are many e-commerce applications such as electronic procurement, which enables workers to place purchase orders through Internet.

There are already information systems developed to support mobile workers. The classical mobile work support systems are service delivery and job dispatching systems, emergency response systems, etc. Dispatching systems, such as supply chain logistics, taxi dispatching system, can greatly improve the productivity of mobile work and save cost. Emergency response systems are aimed to support firefighters, police, and other rescuer workers to communicate and collaborate in rescue operations while crises happen. A crisis can occur anywhere at any time, and the people whose job is to respond might be geographically dispersed. Flexible and robust mobile support systems are paramount for helping ensure that the crisis is handled in the most efficient and effective manner possible (Yuan and Detlor, 2005).

7.   RESEARCH ISSUES

Based on the conceptual framework of mobile work support, we can identify related research issues for future studies.

1) What factors determine or affect the mobile workers' acceptance of mobile work support? What are the privacy issues that mobile workers may concern? Mobile work support may improve the job performance of mobile workers, but may also increase their workload and change their work style or habit. The requirements of all-time connection and the capability of tracing the location of mobile workers may also raise the privacy concerns of mobile workers (Casal, 2003).

2) How to measure the performance of mobile work? How mobile technologies, such as location identification and ubiquitous communication, help to improve the mobile task performance? How will mobile work support system change the way the business is conducted? There are lots of studies on the Business Process Re-engineering (BPR) in the application of ERP, however, there are few studies that address BPR issues in the implementation of mobile work support systems. While mobile technologies promises to have the great potentials to fundamentally change the way of doing business, how to make the change and how to deal with it are still unclear.

3) How can mobile work support be adapted to various mobile working environments? How to cope with various and different levels of uncertainty of mobile work? How to enhance time management of mobile workers? The dynamic work place and irregular work temporal structure are the most important characteristics for mobile work, how to deal with them is very important for the design of a mobile work support system.

4) What are the usability issues of mobile devices in mobile context? How to make the mobile devices fit into different usage situations? How to integrate mobile work support with enterprise information systems? We need to study the implementation and design issues of different type of mobile work support systems such as emergency response systems, job dispatching systems, mobile health services, and mobile sales force management etc.

8.   CONCLUSION

The conceptual framework proposed in this paper helps us to better understand the nature of mobile work and the needs for mobile work support. We conclude that mobile workers form a new group of users who need to move around. Their jobs are location and time dependent and have to deal with greater uncertainty. They have to carry their own "portable office" or borrow others' place. They need to adapt to a dynamic environment with limited support and cope with external interference. They often have to work under time pressure without full self-control. The advances of mobile devices and mobile communication networks provided potential for mobile work support but the technology is not mature yet and there are still great challenges for us to realize this potential. Many research questions need to be answered in order to provide meaningful support. Based on the understanding of mobile work, we could further develop guidelines for businesses to strategically plan and deploy mobile work support systems. It also can help businesses to assess how the mobile work support may affect their existing business models and

develop proactive strategies to derive the greatest benefit from the technological and social changes.

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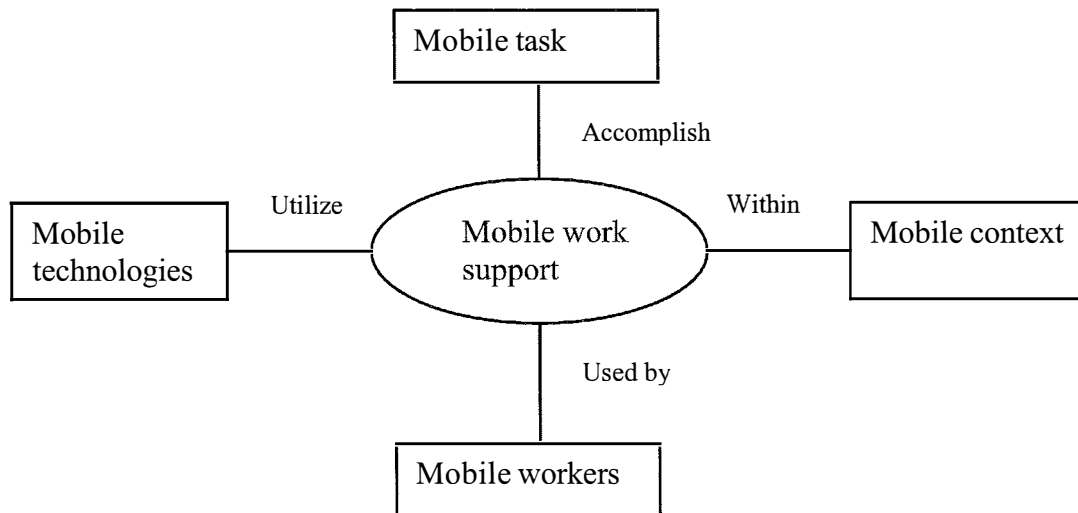
Figure 1. **Concept Framework of Mobile Work Support**

Table 1. Dimensions of the Mobile Work Framework

Dimensions	Questions to address	Characteristics
Worker (Who)	Who are the mobile workers?	Mobility and job category
Task (What)	What tasks the mobile workers perform?	Location/time dependency, multi-task handling
Context (Where and When)	What environment in which the tasks are performed by mobile workers?	Workplace and temporal structure
Technology (How)	What information technologies are available to support mobile work?	Mobile devices, mobile communication infrastructure, and applications

Table 2. Comparison of Stationary Work Support and Mobile Work Support

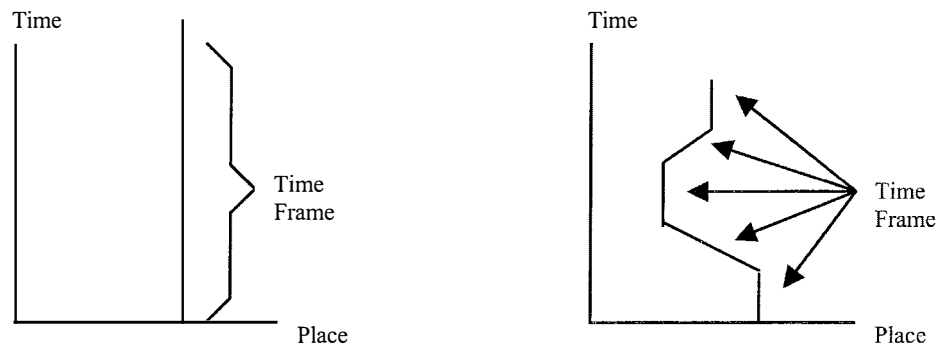|	Stationary work	Mobile work
1. Worker		
Mobility	Stationary	Mobile
Job category	Office workers	Traveling and field workers.
2. Task		
Location/time dependency	Be performed independent from the location and time	Must be performed on the site within a specific time frame
Multi-task handling	Information processing is a dominative activity	Information processing is secondary to other major activities
3. Context		
3.1 Work place		
Location	Stationary	Dynamic (Variable)
Ownership	Owned	Carried or borrowed
Adaptation	Office is designed to fit workers	Workers adapt to the available work place
Facilities	Fully supported	Quite limited and restricted
Uncertainty	Relatively low	High
Interference	Less and can be controlled	Heavy and need to cope with
3.2 Temporal Structure		
Working time	Regular	Irregular
Time frame of actions	Wide	Narrow
Time management	Relatively more controllable	Relatively less controllable
4. Technology		
4.1 Devices		
Portability	Not portable	Portable or moveable
Interface	Standard PC interface	A variety of non-standard small device interfaces
Processing capability	Powerful	Limited due to the trade-off of portability
4.2 Infrastructure		
Connectivity	Fixed line global connection to office	Wireless regional connection to devices carried by a person
Location identification capability	No	Different location identification technologies are available
Application interoperability	High interoperability	Low interoperability
Standardization & Compatibility	Universal standardization and high compatibility	Lack of universal standard and low compatibility
Reliability	High	Relatively low
4.3 Support systems		
Typical applications	Office Automation; Groupware; Electronic procurement system.	Service delivery and job dispatching systems; Emergency response systems.

Time

Time
Frame

Place

Time

Time
Frame

Place

Figure 2. Temporal Structure

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